Please add an Abstract of the Disclosure submitted herewith on a separate page.

REMARKS

Entry of the amendments to the specification and claims, as amended before examination of the application in the U.S. National Phase is respectfully requested. If there are any questions regarding this Preliminary Amendment or this application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response, and please charge any deficiency in fees or credit any overpayments to Deposit Account No. 05-1323 (Docket #951/48911).

Respectfully submitted,

June 12, 2000

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--<u>**ABSTRACT OF THE DISCLOSURE**</u>

A system for supplying electricity to a motor vehicle using a capacitor having a maximum value greater than the maximum value of a rechargeable battery. A transformer provides discharging of the battery from its maximum voltage down to the maximum voltage of the battery in order to provide excess energy in a short period of time to effectively charge the battery and simultaneously increase the service life of the chargeable battery.--

TITLE OF THE INVENTION

DEVICE FOR SUPPLYING ELECTRICITY TO A MOTOR VEHICLE

BACKGROUND AND SUMMARY OF THE INVENTION

This application claims the priority of German Application 19754964.0, filed December 11, 1997, the disclosures of which is expressly incorporated by reference herein.

The invention relates to a device for supplying electricity to a motor vehicle according to the preamble of Claim 1.

A device of this type is known, for example, from German Patent Document DE 43 40 350 C2. This known device has a rechargeable battery, a capacitor which can be switched in parallel to the battery, and a circuit arrangement in the form of a logic circuit arranged between the battery and the capacitor. When the starter in the vehicle is actuated, the logic circuit defines a time window and carries out at least one voltage query. As a function of the result of this voltage query, the logic circuit switches the capacitor in parallel to the battery. The capacitor is preferably switched in parallel only when the voltage of the battery within the time window falls below a predetermined value. By means of this known circuit arrangement, [by way of] with the capacitor switched in parallel to the battery, the starting of the vehicle is [to be also] still

ensured when the battery is almost discharged. However, [by means of] with the parallel connection of the capacitor with the battery, [only a maximal] the maximum capacitor voltage [can be reached whose value] cannot exceed the value of the battery voltage. This known circuit arrangement is therefore not suitable for storing [by means of] in the capacitor a high excess of energy for a short time and thus for effectively recharging a discharged battery.

In addition, a circuit arrangement for supplying electricity to a motor vehicle is known from German Patent Document DE 195 22 563 A1, in the case of which the energy stored in a capacitor, particularly the electric energy generated during a recuperative braking, is fed to a rechargeable battery in a controlled manner. However, this known circuit arrangement discloses no details concerning the type of the control [as well as concerning] or the ratio of the maximally possible capacitor voltage to the battery voltage.

Furthermore, with respect to the technical environment, reference is made to European Patent Document EP 0 568 655 B1, from which a device is known for supplying electricity to a motor vehicle which has two chargeable batteries of different nominal voltages and a circuit arrangement in the form of a voltage transformer arranged between the batteries.

It is an object of the invention to [improve a] provide an improved device of [the initially mentioned] type for [the supply] supplying of electricity to a motor vehicle such that, on the one hand, an energy excess which is available for a short time is effectively utilized for charging a vehicle battery and simultaneously the service life of the rechargeable vehicle battery is increased.

[This object is achieved by means of the characterizing features of Claim 1. An advantageous further development of the invention is the object of Claim 2.]

The use of a capacitor (such as a Power Cap or Super Cap) whose nominal voltage and thus its maximally possible voltage is preferably several times higher than the nominal voltage of the battery is essential to the invention. By using such a buffer capacitor with a large voltage variation range as the energy accumulator, the voltage at the capacitor can be significantly increased beyond the battery voltage in order to be able to store in the best possible manner, [in the case of] a short-term energy excess, as, for example, [as the result of] resulting from recuperative braking[, this energy excess in the best possible manner]. The battery is charged in a controlled manner by means of this capacitor by [way of a] using a voltage transformer, preferably a DC/DC converter.

In a particularly advantageous further development of the invention, the charging of the battery is controlled by means of the capacitor by way of the voltage converter such that the charged capacitor is maximally discharged until a capacitor voltage is reached which is approximately equal to the momentary actual voltage of the battery. By means of this advantageous further development, a circuit arrangement can be used as a voltage transformer which only has to carry out a "downward" transformation in the sense of a voltage reduction starting from the capacitor voltage. As the result, the voltage transformer can be built [up], in a particularly simple manner, at reasonable cost, between the battery and the capacitor.

The invention also [comprises] <u>includes</u> an expanded voltage transformer in such a manner that, in the reverse direction, the capacitor can be charged by way of the battery to a voltage whose value is larger than the value of the battery voltage.

The circuit arrangement according to the invention is used in the case of motor vehicles with a chargeable battery which has a higher than [the] conventional nominal voltage (for example, 36 V instead of 12 V) in order to ensure the supply of high-power consuming devices whose number is constantly increasing in motor vehicles.

[By means of the] With device for supplying electricity according to the invention, on the one hand, an energy excess which is available for a short time is effectively utilized and, on the other hand, a variable multivoltage electrical wiring is permitted.

Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawing illustrates an embodiment of the invention.

Figure 1 is a view of a circuit arrangement according to the invention;

Figure 2 is a view of a possible course of the capacitor voltage according to the control of the invention for charging the battery.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In Figure 1, a capacitor 1 is connected by way of a voltage transformer 2, which preferably is a DC/DC converter, with a vehicle battery 3. As the capacitor 1, a buffer capacitor (power Cap), is preferably used which has a nominal voltage or maximally possible voltage $U_{C\ max}$ of, for example, 80 V. The battery 3 is, for example, a conventional battery with a nominal voltage U_B of, for example, 36 V. Thus, the nominal voltage of the capacitor 1 is [approximately by the factor 2] larger than the nominal voltage of the battery approximately by a factor 2.

The capacitor 1 can be charged by way of an electric connection A which is connected, for example, with a generator for the braking energy recirculation. The capacitor voltage U_C is directly proportional to the charging condition of the capacitor 1. The ratio of the charging condition or of the charged amount of energy E to the capacitor voltage U_C is obtained by the following formula: $E = 1/2 \bullet C \bullet U_C^2$[;]. [i]In the case of the double voltage U_C, four times the amount of Energy E can therefore be accumulated.

[In addition, it is pointed out that] Additionally, as a result of its cycle stability and full-load stability, the service life of such a capacitor is significantly longer than that of a conventional motor vehicle battery.

If the capacitor 1 is charged at least in such a manner that the capacitor voltage U_C is higher than the actual voltage $U_{B\ actual}$ of the battery 3, the voltage transformer 2 controls the charging of the battery 3 by the capacitor 1 corresponding to the requirement of the battery 3 and/or [the] an electrical wiring (not shown here) optionally connected with the battery 3.

Figure 2 illustrates in detail the manner and mode of the control of the voltage transformer 2. On the X-axis, Figure 2 shows the load condition L or the accumulated amount of energy E and, on the Y-axis, Figure 2 shows the pertaining capacitor voltage U_C. According to the invention, for example, based on a completely charged capacitor 1 ($U_C = U_{C\ max}$), the charging of the battery 3 by the discharging of the capacitor 1 is maximally carried out until the capacitor voltage U_C has approximately reached the value of the actual voltage $U_{B\ actual}$ of the battery voltage 3. As a result, the voltage transformer 2 must carry out only a voltage downward transformation. If the capacitor 1 were to be discharged further, starting from the falling below the capacitor voltage $U_C = U_{B\ actual}$, the voltage transformer 2 would have to carry out a voltage upward transformation in the sense of a voltage increase. Although this can be technically implemented, it is inefficient in view of the requirement to have an efficiency which is [to be] as high as possible.

If, as in the illustrated embodiment according to Figure 2, a discharge of the capacitor 1 has taken place starting from a voltage U_C = 80V in such manner that the capacitor voltage U_C has reached the value of the actual voltage $U_{B\ actual}$ = 36 V ([here] equal to the nominal voltage U_B=36 V) of the battery 3, because of the above-mentioned relationships between the load condition L or the amount of energy E and the capacitor voltage U_C, in the event of a decrease of the capacitor voltage U_C [here] by approximately half, 3/4 of the amount of energy E accumulated in the capacitor was already delivered to the battery 3.

By means of this control of the charging of the battery according to the invention, an optimal compromise is achieved between the circuit-related expenditures of the voltage transformer 2 and a utilization of the energy excess charged in the capacitor 1 for a short time, which is as efficient as possible.

The foregoing disclosure has been set forth merely to illustrate the invention and is not intended to be limiting. Since modifications of the disclosed embodiments incorporating the spirit and substance of the invention may occur to persons skilled in the art, the invention should be construed to include everything within the scope of the appended claims and equivalents thereof.

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battery is almost discharged. However, with the parallel connection of the capacitor with the battery, the maximum capacitor voltage cannot exceed the value of the battery voltage. This known circuit arrangement is therefore not suitable for storing in the capacitor a high excess of energy for a short time and thus for effectively recharging a discharged battery.

In addition, a circuit arrangement for supplying electricity to a motor vehicle is known from German Patent Document DE 195 22 563 A1, in the case of which the energy stored in a capacitor, particularly the electric energy generated during a recuperative braking, is fed to a rechargeable battery in a controlled manner. However, this known circuit arrangement discloses no details concerning the type of the control or the ratio of the maximally possible capacitor voltage to the battery voltage.

Furthermore, with respect to the technical environment, reference is made to European Patent Document EP 0 568 655 B1, from which a device is known for supplying electricity to a motor vehicle which has two chargeable batteries of different nominal voltages and a circuit arrangement in the form of a voltage transformer arranged between the batteries.

It is an object of the invention to provide an improved device of type for supplying of electricity to a motor vehicle

such that, on the one hand, an energy excess which is available for a short time is effectively utilized for charging a vehicle battery and simultaneously the service life of the rechargeable vehicle battery is increased.

The use of a capacitor (such as a Power Cap or Super Cap) whose nominal voltage and thus its maximally possible voltage is preferably several times higher than the nominal voltage of the battery is essential to the invention. By using such a buffer capacitor with a large voltage variation range as the energy accumulator, the voltage at the capacitor can be significantly increased beyond the battery voltage in order to be able to store in the best possible manner, a short-term energy excess, as, for example, resulting from recuperative braking. The battery is charged in a controlled manner by means of this capacitor by using a voltage transformer, preferably a DC/DC converter.

In a particularly advantageous further development of the invention, the charging of the battery is controlled by means of the capacitor by way of the voltage converter such that the charged capacitor is maximally discharged until a capacitor voltage is reached which is approximately equal to the momentary actual voltage of the battery. By means of this advantageous further development, a circuit arrangement can be used as a voltage transformer which only has to carry out a "downward"

transformation in the sense of a voltage reduction starting from the capacitor voltage. As the result, the voltage transformer can be built, in a particularly simple manner, at reasonable cost, between the battery and the capacitor.

The invention also includes an expanded voltage transformer in such a manner that, in the reverse direction, the capacitor can be charged by way of the battery to a voltage whose value is larger than the value of the battery voltage.

The circuit arrangement according to the invention is used in the case of motor vehicles with a chargeable battery which has a higher than conventional nominal voltage (for example, 36 V instead of 12 V) in order to ensure the supply of high-power consuming devices whose number is constantly increasing in motor vehicles.

With device for supplying electricity according to the invention, on the one hand, an energy excess which is available for a short time is effectively utilized and, on the other hand, a variable multivoltage electrical wiring is permitted.

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Additionally, as a result of its cycle stability and full-load stability, the service life of such a capacitor is significantly longer than that of a conventional motor vehicle battery.

If the capacitor 1 is charged at least in such a manner that the capacitor voltage U_C is higher than the actual voltage $U_{B\ actual}$ of the battery 3, the voltage transformer 2 controls the charging of the battery 3 by the capacitor 1 corresponding to the requirement of the battery 3 and/or an electrical wiring (not shown here) optionally connected with the battery 3.

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completely charged capacitor 1 ($U_C = U_{C\,max}$), the charging of the battery 3 by the discharging of the capacitor 1 is maximally carried out until the capacitor voltage U_C has approximately reached the value of the actual voltage $U_{B\,actual}$ of the battery voltage 3. As a result, the voltage transformer 2 must carry out only a voltage downward transformation. If the capacitor 1 were to be discharged further, starting from the falling below the capacitor voltage $U_C = U_{B\,actual}$, the voltage transformer 2 would have to carry out a voltage upward transformation in the sense of a voltage increase. Although this can be technically implemented, it is inefficient in view of the requirement to have an efficiency which is as high as possible.

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